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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description ot the validation sample and a personnel evaluation form are also included. (AG)

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Development of USTES Aptitude Test Battery

for

Part Programer, Numerical Control

(mach. shop.) II 007.187

U.S. DEPARTMENT OF LABOR
MANPOWER ADMINISTRATION

ED 068562

Technical Report on Development of USTES Aptitude Test Battery For . . . . . .

Part Programer, Numerical Control (mach. shop.) II 007.187

S-431

(Developed in Cooperation with the
Ohio State Employment Service)

U. S. Department of Labor
Manpower Administration

March 1969

FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study #2732

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

For

Part Programer, Numerical Control (mach. shop.) II 007.187-016

S-431

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Part Programer, Numerical Control (mach. shop.) II 007.187-016. Specifically those workers engaged in programing for two or three axis metal-cutting machinery. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
G - General Learning Ability	105
V - Verbal Aptitude	105
N - Numerical Aptitude	100

RESEARCH SUMMARY

Sample:

Fifty-six male workers and 1 female worker employed as Part Programers by various firms in Ohio. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group composition is unknown.

Criterion:

Supervisory ratings.

Design:

Concurrent (test and criterion data collected at approximately the same time.)

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Concurrent Validity:

Phi Coefficient = .35 ($P/2 < .005$)

Effectiveness of Norms:

Only 72% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the above norms, 86% would have been good workers. Twenty-eight percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the above norms, only 14% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1.

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	72%	86%
Poor Workers	28%	14%

VALIDATION SAMPLE DESCRIPTION

Size: N=57

Occupational Status: Employed workers

Work Setting: Workers employed by various firms in Ohio

Selection Requirements:
Education: Varies from high school to two years of college.
Previous Experience: Varies from none (employers train) to two years.
Tests: None
Other: Some companies require physical examination. All require personal interview. Most have promoted from ranks of machinists or tool room clerks.

Principal Activities: The job duties for each worker are comparable to those described in the job description in the Appendix.

Minimum Experience: No workers were tested who had less than one year experience on the job.

TABLE 2

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for Age , **Education and Experience**

	Mean	SD	Range	r
Age (years)	35.3	**8.5**	22-54	.099
Education (years)	13.6	1.9	12-17	.099
Experience (months)	**36.4**	**21.6**	**12-140**	**.335***

*** Significant at the .05 level**

EXPERIMENTAL TEST BATTERY

All twelve tests of the GATB, B-1002B were administered to the validation sample during the period August 1967 through December 1967.

CRITERION

The criterion data consisted of supervisors' ratings of job proficiency. Ratings were obtained twice (two weeks apart) and correlated.

Rating Scale: A special rating scale was devised for this study. The scale (see Appendix) contained eight items covering different aspects of job performance with five alternative levels of performance for each.

Reliability: A reliability coefficient of .86 was obtained between the two ratings. The final criterion consists of the combined scores of the two ratings.

Criterion Score Distribution:

Possible Range	16-80
Actual Range	46-80
Mean:	64.0
Standard Deviation:	8.7

Criterion Dichotomy: The criterion distribution was dichotomized into high and low groups by placing 28% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 59.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of the job duties involved and a statistical analysis of test and criterion data. Aptitudes V, N, and S which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated they were important to the job duties and the sample had a relatively high mean score on N and S and a relatively low standard deviation on V and S. Aptitude Q which does not have a high correlation with the criterion was considered for inclusion in the norms because it was judged critical to the job duties. With employed workers a relatively high mean score or relatively low standard deviation indicates that some sample pre-selection may have taken place. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis

(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Required to assimilate intensive cognitive training and to learn new processes and procedures.
V - Verbal Aptitude	Required to read and comprehend trade literature and to communicate with people in design and operations.
N - Numerical Aptitude	Required for computational tasks in converting dimensional data on drawings to base point reference.
S - Spatial Aptitude	Required in visualizing product from two-dimensional drawings or sketches.
Q - Clerical Aptitude	Required in analyzing specification sheets, cross checking data on various papers.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

Aptitudes	Mean	SD	Range	r
G - General Learning Ability	123.7	13.5	96-154	.269*
V - Verbal Aptitude	110.4	14.7	76-133	.253
N - Numerical Aptitude	122.4	16.0	80-158	.227
S - Spatial Aptitude	121.5	14.4	78-147	.115
P - Form Perception	122.4	20.8	73-160	-.046
Q - Clerical Perception	120.1	17.9	90-151	.144
K - Motor Coordination	102.1	18.1	51-132	.162
F - Finger Dexterity	98.9	15.3	68-137	.065
M - Manual Dexterity	104.0	21.9	53-152	.060

* Significant at the .05 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data:						*			
Important	X	X	X	X		X			
Irrelevant							O	O	
Relatively High Mean	X		X	X	X				
Relatively Low Standard Dev.	X	X		X					
Significant Correlation with Criterion	X								
Aptitudes to be Considered for Trial Norms	G	V	N	S		* Q			

* Considered critical to job duties

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of Aptitudes G,V, N, S, and Q at trial cutting scores were able to differentiate between the 72% of the sample considered good workers and the 28% of the sample considered poor workers. Trial cutting scores at five point intervals one standard deviation below the mean are tried because this will eliminate about one-third of the sample with three-aptitude norms. For two-aptitude trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample. For four-aptitude trial norms, cutting scores of slightly less than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. The optimum differentiation for the occupation of Part Programer, Numerical Control (mach. shop) II 007.187-016 was provided by the norms of G-105, V-105, and N-100. The validity of these norms is shown in Table 6 and is indicated by a Phi Coefficient of .35 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms, G-105, V-105, and N-100

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good workers	11	30	41
Poor workers	11	5	16
Total	22	35	57

Phi Coefficient (ϕ) = .35 Chi Square (X^2_y) = 6.9

Significance Level = $P/2 < .005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP 3 in Section II of the Manual for the General Aptitude Test Battery. **A Phi Coefficient of .43 is obtained with the OAP-3 norms of G-110, V-105, N-105.**

SPECIAL RATING SCALE

A. How well can he read blueprints? (Worker's ability to fully and completely read blueprints and to conceptualize the piece to be machined.)

B. How accurate are his programs? (Worker's ability to design a program which will produce a part finished to the required tolerances.)

C. Rate at which work is accomplished. (Compare the rate at which he is able to complete assigned jobs with the rates being maintained by other workers.)

D. What is the level of his ability to communicate with others? (Worker's ability to receive and transmit written and oral information concerning technical matters. This assumes that the Part Programer is in a position between the Engineering Designer and the NC Machine Operator with respect to "lines of communication.")

E. Acquisition and comprehension of job information. (Worker's ability to acquire and understand information about principles, equipment, materials, methods, feeds and speeds, etc., involved in this type of work.)

F. How large a variety of job duties can he perform? (Compare worker's ability to program for a variety of types of metal-cutting machinery with that of his fellow workers.)

G. How often does he make practical suggestions for doing things in better ways? (Compare worker's ability to improve work methods with the ability of other workers.)

H. Overall job performance. (Considering only those factors on which he has been rated, compare his total overall job performance with that of other workers.)

L. How often do you see this worker in a work situation?

1. All the time
2. Several times a day
3. Several times a week
4. Seldom

M. How long have you worked with him?

1. Under one month
2. One to two months
3. Three to five months
4. Six or more months.

PERFORMANCE LEVELS

1. Capable of outstanding performance in this respect. Probably falls within the top ten per cent of all persons doing this type of work.

2. Performs at an above average level. Could be considered as being in the upper third of all workers in this occupation.

3. Usual performance is at a satisfactory level. In this respect, probably falls somewhere near the average of all persons doing this kind of work.

4. Shows somewhat limited capabilities in this aspect of the job. Could be considered as being in the lower third of all workers in this occupation.

5. Has demonstrated very definite limitations in this respect. Performance is probably similar to that of the lower ten per cent of all persons doing this work.

FACT SHEET

Job Title: Part Programer, Numerical Control (mach. shop.) II 007.187-016

Job Summary: Translates engineering drawings and sketches to symbols placed on tape to control metal-cutting machine tools.

Work Performed: Writes part programs defining setup, tooling, and nature and sequence of numerically controlled machine tool operations, to machine parts as specified on engineering drawings and sketches, by applying knowledge of machining practices and shop methods : Studies design data and drawings to determine intent of designer, and visualize workpiece configuration and setup location and orientation on machine tool. Designates base point for machining when not specified, by applying knowledge of numerical machining practices. Converts dimensional data on drawings to base point reference, by using mathematics at levels of arithmetic, geometry, and trigonometry, when conventional rather than cartesian-coordinate drafting practices are used by workpiece designers. Applies familiarity with capabilities and limitations of specific numerically controlled machine tool such as horizontal boring and milling machine or vertical turret lathe, and knowledge of shop practices and physical properties of materials, to plan sequence and nature of machining procedures. Writes detailed, sequential statement of machine commands and operator instructions, using specialized language, symbols and (usually) planning sheets, to specify location and orientation of workpiece and fixturing, and other factors such as tool path and dimensional tolerance data, feedrates and speeds, size and type of cutting tools, movements of machine table, and programed machine stops for inspection or tool changes. May operate desk calculator with square-root generator, or input-output terminal to remote computer, in order to simplify computational tasks. Develops tool path sketches to plan milling procedures and assure clearances when part is machined: Prepares tooling and fixturing sketches and specifications. Defines information needs, of operator, and prepares separate, abbreviated operator manuscript, when detailed process sheets are not used on machine floor. Reviews completed process manuscripts prepared by self, or cross-checks those of others, to detect and correct errors. Routes process sheets to computer center of clerical pool, for preparation of computer-printed or typed copy, and paper or magnetic tape used to control machine tool. Reviews returned copy, and cross-verifies with original, in final effort to detect and correct part programing and processing errors before release to manufacturing group. Reads trade literature to keep informed on improvements in equipment, and processing and manufacturing techniques. May observe machining of first part with unproven tape when numerical control installation is new and personnel relatively inexperienced, or when unusual machining problems are anticipated. May confer with design personnel, applying specialized knowledge of numerical control to determine product machinability, and suggest changes in design and drafting practices. May develop or refine time and cost data as by-product of part program, to eliminate duplication of effort by industrial engineering department. May organize training materials and instruct in part programing and operation of numerically controlled machine tools. May originate or modify computer programs and routines that simplify part programing.

Effectiveness of Norms:
Only 72% of the non-test-selected workers used for this study were good workers; if the workers had been test-selected with the S-431 norms, 86% would have been good workers. Twenty-eight percent of the non-test-selected workers used for this study were poor workers; if the workers had been test-selected with the S-431 norms, only 14% would have been poor workers.

Applicability of S-431 Norms;
The aptitude test battery is applicable to jobs which embody a majority of the job duties described above.

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